

Application No.: 10/714,966

Docket No.: 20140-00308-US1

AMENDMENTS TO THE CLAIMS

1. (Original) A composite material comprising:
a layer containing copper; and
an electrodeposited CoWP film on the copper layer, wherein the CoWP film contains from 11 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm.
2. (Original) The composite material of claim 1 wherein the CoWP film contains from 3 atom percent to 10 atom percent tungsten as measured by Rutherford backscattering spectroscopy.
3. (Original) The composite material of claim 1 wherein the CoWP film consists essentially of $\text{Co}_x\text{W}_y\text{P}_z$ wherein $0.68 < x < 0.88$; $0.01 < y < 0.10$; and $z = (1 - (x + y))$ as measured by Rutherford backscattering spectroscopy.
4. (Original) The composite material of claim 3 wherein $0.77 < x < 0.83$ and $0.03 < y < 0.07$.
5. (Original) The composite material of claim 1 wherein the copper layer is disposed between the CoWP film and a metal layer.
6. (Original) The composite material of claim 5 wherein the copper layer and the metal layer is disposed within a trench or via of a dielectric material.
7. (Original) The composite material of claim 6 further comprising a metal cap layer on the CoWP film, wherein the CoWP film and the metal cap layer are disposed within the trench or the via of the dielectric material.
8. (Original) The composite material of claim 1 wherein the CoWP film has a thickness from 5 nm to 50 nm.

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9. (Original) The composite material of claim 1 wherein the CoWP film has a thickness from 10 nm to 30 nm.

10. (Original) The composite material of claim 1 wherein the atom percent phosphorous is measured by Rutherford backscattering spectroscopy.

11. (Withdrawn) A method of making an interconnect structure comprising:
providing a trench or via within a dielectric material, and a conducting metal containing copper within the trench or the via; and
forming a CoWP film by electrodeposition on the copper layer, wherein the CoWP film contains 10 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm.

12. (Withdrawn) The method of claim 11 wherein the CoWP film contains from 3 atom percent to 10 atom percent tungsten as measured by Rutherford backscattering spectroscopy.

13. (Withdrawn) The method of claim 11 wherein the CoWP film consists essentially of $\text{Co}_x \text{W}_y \text{P}_z$ wherein $0.68 < x < 0.88$; $0.01 < y < 0.10$; and $z = (1 - (x + y))$ as measured by Rutherford backscattering spectroscopy.

14. (Withdrawn) The method of claim 13 wherein $0.77 < x < 0.83$ and $0.03 < y < 0.07$.

15. (Withdrawn) The method of claim 11 further comprising depositing a metal layer along the sidewalls of the trench or via, wherein the copper layer is disposed between the CoWP film and the metal layer.

16. (Withdrawn) The method of claim 11 further comprising removing a portion of the copper conducting metal to form a recessed structure prior to forming the CoWP film.

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17. (Withdrawn) The method of claim 16 further comprising forming a metal cap layer on the CoWP film.

18. (Withdrawn) The method of claim 11 wherein the CoWP film has a thickness from 5 nm to 50 nm.

19. (Withdrawn) The method of claim 11 wherein forming the CoWP film comprises providing the electroplating bath solution at a pH from 7 to 10.

20. (Withdrawn) The method of claim 19 wherein forming the CoWP film comprises applying a current density of 3 mA/cm² to 20 mA/cm².

21. (Withdrawn) The method of claim 11 wherein the atom percent phosphorous is measured by Rutherford backscattering spectroscopy.

22. (Original) An interconnect structure comprising:
a dielectric layer in contact with a metal layer;
an electrodeposited CoWP film on the metal layer, wherein the CoWP film contains 11 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm; and
a conducting layer containing copper on the CoWP film.

23. (Original) The interconnect structure of claim 22 wherein the CoWP film contains from 3 atom percent to 10 atom percent tungsten as measured by Rutherford backscattering spectroscopy.

24. (Original) The interconnect structure of claim 22 wherein the CoWP film consists essentially of Co_xW_yP_z, wherein 0.68 < x < 0.88; 0.01 < y < 0.10; and z = (1 - (x + y)) as measured by Rutherford backscattering spectroscopy.

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25. (Original) The interconnect structure of claim 24 wherein $0.77 < x < 0.83$ and $0.03 < y < 0.07$.

26. (Original) The interconnect structure of claim 22 further comprising a capping material on the copper conducting layer, wherein the capping material consists essentially of $\text{Co}_x\text{W}_y\text{P}_z$, and $0.68 < x < 0.88$; $0.01 < y < 0.10$ and $z = (1 - (x + y))$ as measured by Rutherford backscattering spectroscopy.

27. (Original) The interconnect structure of claim 26 wherein the capping material has a thickness from 5 nm to 50 nm.

28. (Original) The interconnect structure of claim 22 wherein the copper conducting layer is recessed within the dielectric layer.

29. (Withdrawn) A method of making an interconnect structure comprising:
providing a trench or via in a dielectric layer, wherein the trench or the via has sidewall surfaces in contact with a metal layer;
forming a CoWP film by electrodeposition on the metal layer, wherein the CoWP film contains 10 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm; and
forming a copper layer on the CoWP film.

30. (Withdrawn) The method of claim 29 wherein forming the CoWP films comprises maintaining the electroplating both solution at a pH from 7 to 10.

31. (Withdrawn) The method of claim 30 wherein forming the CoWP films comprises applying a current density of 3 mA/cm^2 to 20 mA/cm^2 .

32. (Presently Amended) An interconnect structure comprising:

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a trench or a via disposed within a dielectric material, wherein the trench or via is filled with a metal layer disposed along the sidewalls of the trench or the via, and a conducting layer containing copper; and

an amorphous electrodeposited CoWP film on the copper layer, wherein the CoWP film contains 11 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm.

33. (Original) The interconnect structure of claim 32 wherein the CoWP film contains from 3 atom percent to 10 atom percent tungsten as measured by Rutherford backscattering spectroscopy.

34. (Original) The interconnect structure of claim 32 wherein the CoWP film consists essentially of $\text{Co}_x\text{W}_y\text{P}_z$, wherein $0.68 < x < 0.88$; $0.01 < y < 0.10$; and $z = (1 - (x + y))$ as measured by Rutherford backscattering spectroscopy.

35. (Original) The interconnect structure of claim 34 wherein $0.77 < x < 0.83$ and $0.03 < y < 0.07$.

36. (Original) The interconnect structure of claim 32 further comprising a CoWP barrier layer disposed between the copper layer and the metal layer, wherein the CoWP barrier layer consists essentially of $\text{Co}_x\text{W}_y\text{P}_z$, and $0.68 < x < 0.88$; $0.01 < y < 0.10$; and $z = (1 - (x + y))$ as measured by Rutherford backscattering spectroscopy.

37. (Original) The interconnect structure of claim 32 further comprising a metal cap layer on the CoWP film.

38. (Original) The interconnect structure of claim 32 wherein the CoWP film has a thickness from 5 nm to 50 nm.

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39. (Original) The interconnect structure of claim 32 wherein the atom percent phosphorous is measured by Rutherford backscattering spectroscopy.

40. (New) The composite material of claim 1, wherein the CoWP film contains from 13.2 atom percent phosphorus to 25 atom percent phosphorus.

41. (New) The composite material of claim 1, wherein the CoWP film contains from 16.5 atom percent phosphorus to 25 atom percent phosphorus.

42. (New) The interconnect structure of claim 22, wherein the CoWP film contains from 13.2 atom percent phosphorus to 25 atom percent phosphorus.

43. (New) The interconnect structure of claim 22, wherein the CoWP film contains from 16.5 atom percent phosphorus to 25 atom percent phosphorus.

44. (New) The interconnect structure of claim 32, wherein the CoWP film contains from 13.2 atom percent phosphorus to 25 atom percent phosphorus.

45. (New) The interconnect structure of claim 32, wherein the CoWP film contains from 16.5 atom percent phosphorus to 25 atom percent phosphorus.

46. (New) An interconnect structure comprising:
a trench or a via disposed within a dielectric material, wherein the trench or via is filled with a metal layer disposed along the sidewalls of the trench or the via, and a conducting layer containing copper;

an electrodeposited CoWP film on the copper layer, wherein the CoWP film contains 11 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm; and

a CoWP barrier layer disposed between the copper layer and the metal layer, wherein the CoWP barrier layer consists essentially of $\text{Co}_x\text{W}_y\text{P}_z$ and $0.77 < x < 0.83$; $0.03 < y < 0.07$; and $z = (1 - (x + y))$ as measured by Rutherford backscattering spectroscopy.

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47. (New) The interconnect structure of claim 46, wherein the CoWP film contains from 13.2 atom percent phosphorus to 25 atom percent phosphorus.

48. (New) The interconnect structure of claim 46, wherein the CoWP film contains from 16.5 atom percent phosphorus to 25 atom percent phosphorus.

49. (New) A composite material comprising:
a layer containing copper, wherein the copper layer is disposed between a CoWP film and a metal layer, the CoWP film containing from 11 atom percent to 25 atom percent phosphorus and has a thickness from 5 nm to 200 nm, and the copper layer and the metal layer is disposed within a trench or via of a dielectric material; and

a metal cap layer on the CoWP film, wherein the CoWP film and the metal cap layer are disposed within the trench or the via of the dielectric material.

50. (New) The composite material of claim 49, wherein the CoWP film contains from 13.2 atom percent phosphorus to 25 atom percent phosphorus.

51. (New) The composite material of claim 49, wherein the CoWP film contains from 16.5 atom percent phosphorus to 25 atom percent phosphorus.